

LUO CONVERTER DESIGN IN ELECTRIC VEHICLE FOR POWER QUALITY IMPROVEMENT

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Abstract: For maintenance of the grid and reliable to be prepared for the exponential growth of electrical vehicles in the future. The optimal allocation infrastructures, lack of regulations and market rules and network codes devolvement have low visibility on distribution grid. It consist of communicational and computational barriers. A small capacity bidirectional half bridge DC/DC converter is designed to function the harmonics DC to compensate the active power filter (DCAPF) suppress the harmonic current getting into the battery packs in the single stage structure. Finally, both simulation and experimental results are carried out to validate the low order harmonic current compensation effect. The simulation model developed in a MATLAB Simulink tools and verified with corresponding factors. Based on that hardware Prototype is designed.

Keywords: Battery charger, constant current (CC), constant voltage (CV), state of charge (SOC),

I. BACKGROUND OF THE WORK

The crucial link between electric vehicles (EV) with a depleted battery that provides the infrastructure element to electrical source that will recharge those batteries is the Electric Vehicle standards related to current and emerging for EVSE technologies. The assessment codes review the standards related to current and emerging for EVSE technologies. The network of EV charging stations recommendations of infrastructure required to support the accelerating deployment of EVs to expanded their challenges. The network establishment of requirements and needs is the primary barriers which is easy accessible of PEV recharging network communication is the significant barriers are expansion of EVSE infrastructure.

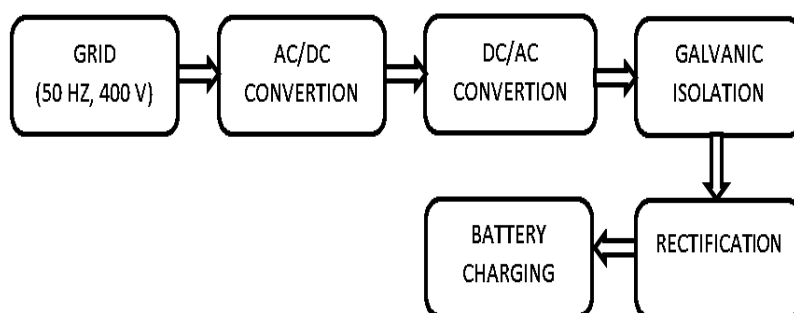


Figure 1.1. DC Charging Method from the Grid

PEV and infrastructure environment focused and consistent public awareness campaigns supporting the continued adoption of PEVs and a public officials and private enterprise want to better understand of PEV and EVSE infrastructure are needed. The manufacture of PEV have near terms expectations for advanced battery technology that will provide a travel range equal to significant advancements are made in PEV technologies for advanced battery technology. The evaluation of performance of electric vehicle charging system is the efficient of key parameters. The shorter charging time for EVs has promising future especially those bidirectional fast chargers among many charging circuit topologies of the concept “vehicle-to-grid (V2G)”.

In commercial EV fast chargers, the downstream DC/DC converter is usually designed to be an isolated converter where a high frequency transformer is necessary for isolation the traditional fast an AC/DC converter and a downstream DC/DC



converter is a usual consists of charging system. The adjustable wide battery range for output voltage for various EVs (280V- 400V).

For the designed to be an isolated converter where a high frequency transformer is necessary for isolation in commercial EV fast chargers, the downstream DC/DC converter. The comparison of the power conversion efficiency is limited to DC/DC converter. Once the non-isolated DC/DC converter is adopted, there must be an influence frequency transformer at the grid side to make sure electrical safety as shown in Figure.1.No matter which type of two-stage converters; it seems difficult to enhance the system efficiency further with lower cost. In this paper, a single-stage AC/DC structure shown in Figure.2 is considered to replace two-stage structure with lower cost but higher efficiency. To accommodate the battery voltage range, the turn ratio of power frequency transformer is designed to make the input voltage of the AC/DC converter lower than the grid voltage.

EFFICIENCY COMPARISION

A system efficiency comparison is carried out between the proposed structure and the traditional two-stage structure. And the efficiency calculation results are validated by the SEMISEL simulation tool. Through the analysis and calculation, the proposed single-stage structure has nearly more than 2% higher power conversion efficiency compared to traditional two-stage structure with no additional cost. Furthermore based on the proposed structure, there is another problem that the harmonic power from the grid can be directly transmitted to the battery packs to be solved. Hence, a small capacity bidirectional half bridge DC/DC converter shown in Figure.3 is applied in this paper to work as an DC active power filter (DCAPF) to compensate the harmonic current as shown in Figure.4. Both the simulation and experimental results indicate that the DCAPF method is effective in battery harmonic current compensation.

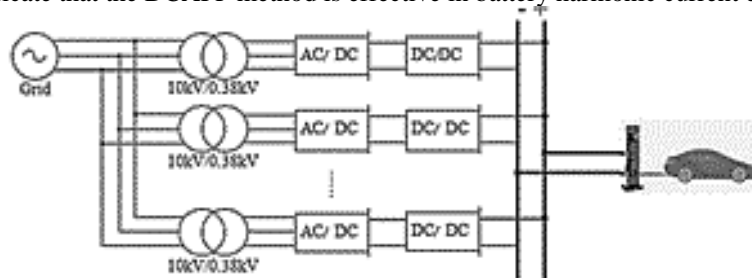


Figure 1.2. Two Stage Charging System

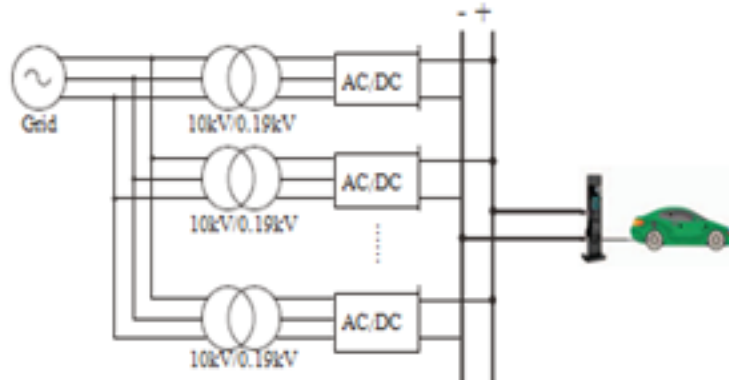


Figure 1.3. Proposed Single Stage Charging System

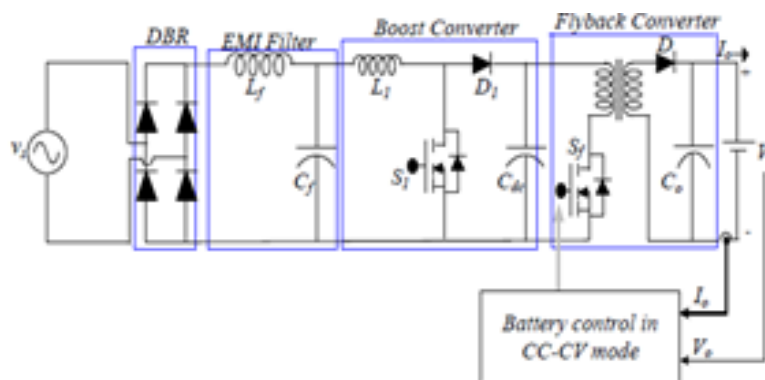


Figure 1.4. Conventional Boost PFC Converter Fed Two Stage EV Charger



However, all these configurations of single-stage single switch solutions seem to be unattractive for high power applications of AC-DC converters, typically, due to increased voltage stress in PFC semiconductor devices, which, in turn, results into lower efficiency. A novel technique based on coupled winding structure is proposed, which reduces the switch voltage and current stress, but the arrangement of coupled winding makes the design of isolation transformer complex and bulky. Lu et al have proposed an integrated boost-forward PFC converter to reduce the main switch current stress with two independent conduction period of mains current. However, the switch voltage stress is clamped at bus voltage using a dual peak-current controller. Therefore, in the proposed work, a two switch technology is applied for significant switch voltage and current stress reduction in isolated Luo converter based EV charger.

PROBLEM STATEMENT

A LUO converter is popularly used as DC-DC converter on account of having improved voltage regulation under sudden varying line voltages and better light load efficiency. The elementary non-isolated positive and negative output LUO converters, are reported in the literature, which have proved their potential for increased voltage conversion ratio, low output ripple and input ripple. The contribution of proposed work is seen in terms of use of LUO converter for improved power factor based EV charger, which has found less exploration in the literature earlier. However, it is noticed that LUO converters are widely used for voltage super-lift, re-lift and ultra-lift applications in literature. A non-isolated bridgeless LUO converter has shown an excellent power factor pre-regulation capability for BLDC motor drive as given. The bridgeless technology facilitates the advantage of comparatively low conduction loss since the line diodes conducting in each switching cycle, are halved.

However, the problem of high switch voltage stress remains in these converters, which, in turn, lowers the converter efficiency. Therefore, a modified isolated LUO converter fed single stage EV charger in DCM, is designed and implemented in this work, to charge a 48V, 100Ah EV battery in constant current and constant voltage (CC-CV) mode. The significant contribution of proposed work is seen with remarkably reduced voltage stress across the PFC switches, which is obtained with certain modification made in the base isolated LUO structure.

The proposed LUO converter is modified version of basic isolated LUO converter with one additional switch and two clamping diodes.

III. BRIDGELESS AC-DC CONVERTER FOR ELECTRIC VEHICLE CHARGER

OBJECTIVE

- The main objective of this project is to design bridgeless AC-DC converter for electric vehicle charger.
- To improve the power quality & THD a closed loop control system is implemented.

SYSTEM DESCRIPTION

- The proposed method is implemented to overcome the power quality issues by selective harmonic distortions of 3rd and 5th order.
- The converter design is based on LUO power factor correction controller.
- PID control logic is applied through the PIC controller.
- To compare the efficiency of the two kinds of structure fairly, the power losses in both transformers and power converters are considered in the following evaluation model.

POWER LOSS ANALYSIS FOR TRANSFORMERS

Assuming that both transformers of the two structures have the same cost, namely the total transmitted power, copper amount and iron core specifications are the same. Usually a transformer's power loss consists of load loss and no-load loss. For the primary side, the power losses are identical in the two transformers due to their same settings. As for the secondary side, it is difficult to compare their power losses directly. Thus, it is necessary to analyze their load losses and no load losses in detail. Under the prerequisite that the iron core specifications are the same in the two transformers, hysteresis loss and eddy current loss of them are considered to be equal as well. As for the load loss, it consists of copper loss, eddy current loss in the winding, and other stray loss. Due to the fact that stray loss is only a small part, it has been ignored in the evaluation. Normally when ignoring the harmonic current in the transformer windings, the copper loss can be expressed as,

$$P = R_{dc} \cdot I^2$$

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$$P_j = R_{dc} \cdot I_1^2$$



Where R_{dc} is the winding's resistance, I_1 is the fundamental current. When the transmitted power is the same in the two transformers, the current of secondary winding at 190V will be twice as high as the secondary winding at 380V. Meanwhile, according to the principle that the copper amount is the same, the cross-sectional area of the secondary winding in (b) is twice as much as in (a), but its length is half of the secondary winding in (a) as shown in Figure.5. Therefore, the dc resistance of secondary winding in (b) is a quarter of that in (a). According to (3), naturally the copper losses are the same when considering the eddy current loss in the winding, it can be calculated through a finite element method as

$$P_i = \frac{1}{24\rho} B_i b \omega^2 R_i S_i$$

where B_i is the flux density in unit i , ω is the angular frequency, ρ is the resistivity, b is the wire size, R_i is the distance from the center of gravity of unit i to the center line of the core, S_i is the area of conductors in unit i . When the finite units are selected to be the same, parameters b , R_i and S_i should be the same for both transformer secondary windings. When the same wire, input source and current density are adopted, parameters ρ , ω and B_i are also the same. Hence, the eddy current losses are the same for two transformers. According to the analysis above, a conclusion can be got that the total power losses of the two transformers are actually identical even under different secondary voltages.

Table 4.1 Parameters of the Converters

Charging system characteristics	Single stage	Double stage
Transmission Power	50 Kw	50 kW
AC/DC Input Voltage	190V	380V
AC/DC Output Voltage	280V~400V	600V
DC/DC Output Voltage	120V	280V~400V
Switching Frequency	12 kHz	12 kHz

Usually the power loss of the power semiconductors consists of conduction loss and switching loss. For the AC/DC converter,

$$P_{cond_T} = \frac{1}{2} \left(V_{CE0} \cdot \frac{i}{\pi} + r_{CE} \cdot \frac{i^2}{4} \right) + m \cos\varphi \left(V_{CE0} \cdot \frac{i}{8} + \frac{i}{3\pi} \cdot r_{CE} \cdot i^2 \right)$$

$$P_{SW} = [E_{on_nom}(V_{nom}, I_{nom}) + E_{off_nom}(V_{nom}, I_{nom})] \cdot \frac{1}{\pi} \cdot f_{sw} \cdot \frac{i}{I_{nom}} \cdot \frac{V_{dc}}{V_{nom}}$$

$$P_{cond_D} = \frac{1}{2} \left(V_{F0} \cdot \frac{i}{\pi} + r_T \cdot \frac{i^2}{4} \right) - m \cos\varphi \left(V_{F0} \cdot \frac{i}{8} + \frac{i}{3\pi} \cdot r_T \cdot i^2 \right)$$

$$P_{rec} = \frac{1}{\pi} \cdot f_{sw} \cdot E_{r_nom}(V_{nom}, I_{nom}) \cdot \left(0.45 \cdot \frac{i}{I_{nom}} + 0.55 \right) \cdot \frac{V_{DC}}{V_{nom}}$$

The conduction loss and the switching loss of the components in the single-stage structure is much less than the power loss in the two-stage structure.

HARMONIC CURRENT SUPPRESSION

When using single-stage structure fast charging system, there is another problem to be solved, that is the harmonic power from the grid may be directly transmitted to the battery packs. Thus similar to the APF applied in ac side, DCAPF method is proposed in this paper to use a small capacity DC/DC converter in the single-stage fast charging system to absorb the harmonic current from the grid. DC/DC converter is connected to the dc-bus to compensate the harmonic current which may be transmitted to battery packs.

For the harmonic current extraction, the dc component is obtained by sampling current through a low pass filter (LPF) and then the harmonic component is obtained by making a difference with the sampling current. As for the voltage loop, it is used to stabilize the voltage of the capacitor C2. Therefore the reference inductor current consists of a small dc component and the extracted harmonic component. Naturally the current loop should contain both PI controller and PR controller to fit for dc and sinusoidal signals.

To verify the DCAPF method, both simulations and experiments are conducted in this paper. For the DC/DC converter. The FFT analysis of the battery current also illustrates that the battery charging current THD has decreased by 5.1%. Meanwhile, the experimental results in Figure.10 agree well with the simulation results. Comparing the waveforms before and after compensation, it is not difficult to find that the harmonic current in the battery has reduced a lot. Also the high-order harmonic current (around 450Hz) increases a little, which may be related to the impedance characteristics of AC/DC converter.

BLOCK DIAGRAM AND CIRCUIT DIAGRAM

The input AC supply is given to the step down transformer. Where 230v AC supply is then converted into 12 v AC supply. This power is directly given to the LUO converter circuit. Where the converter consists of 2 switches and 2



inductors. By controlling these 2 switches the output will be stored in capacitor. This output section again send it to fly back converter. Where the fly back converter converts 24v dc into 240v dc output. Closed loop PID controller where implemented to achieve our goal. The output of fly back converter always constant.

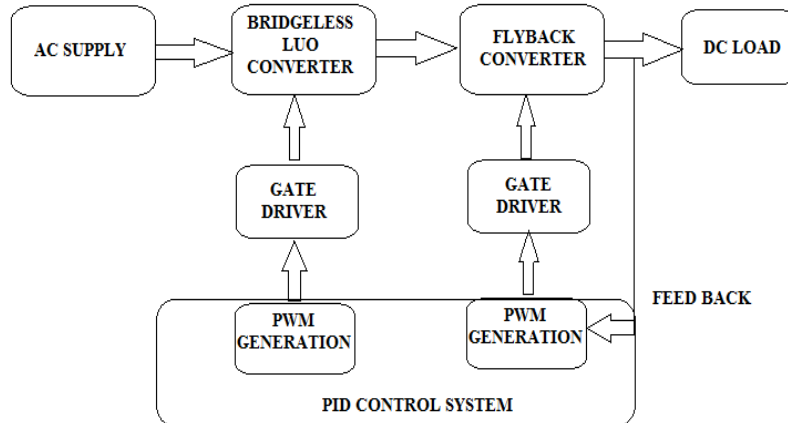


Figure.4.1. Schematic Diagram of Proposed Bridgeless LUO Converter

VI HARDWARE DESCRIPTIONS

PIC16F676 MICROCONTROLLER

The PIC16F676 has a 10-bit A/D converter. They come in 14-pin PDIP, SOIC and TSSOP packages. Figure 4.2 shows a block diagram of the PIC16F630/676 devices.

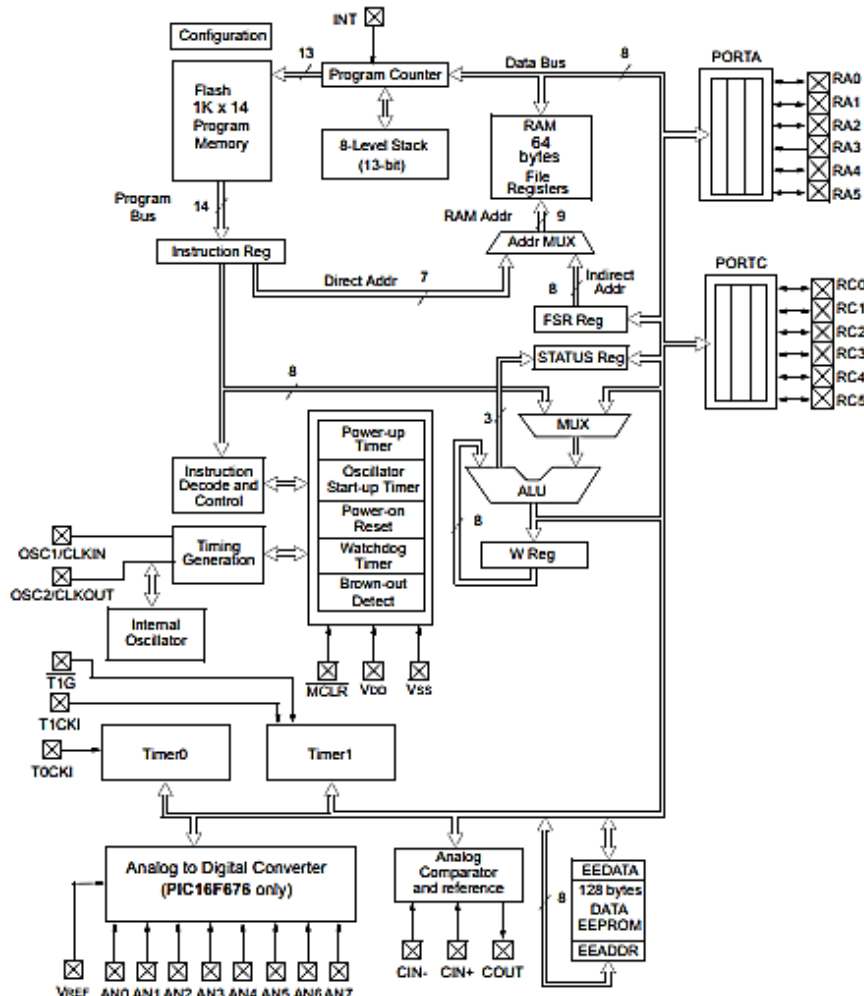


Figure 4.2: PIC16F630/676 Block Diagram



PERIPHERAL FEATURES

- Timer0: 8-bit timer/counter with 8-bit prescaler.
- Timer1: 16-bit timer/counter with prescaler.
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler.
- It has a Capture, Compare, PWM (CCP) module. Capture is of 16-bit and it has a maximum resolution of 12.5 ns. Compare is of 16-bit and it has a maximum resolution of 200ns. Pulse Width Modulation has a maximum resolution of 10-bit. 8-bit,
- 8 channel analog-to-digital converter with 10 bit each.

It has a Synchronous Serial Port (SSP) with SPI (Master/Slave) and I2C, USART with 9 bit detection. It also has a Brown-out detection circuitry for Brown-out Reset (BOR).

CMOS TECHNOLOGY

PIC has a Low power, high speed CMOS FLASH technology with a fully static design. It provides a wide operating voltage range of 2.0V to 5.5V. It has Low power consumption and used in commercial and industrial temperature ranges.

PIN DIAGRAM

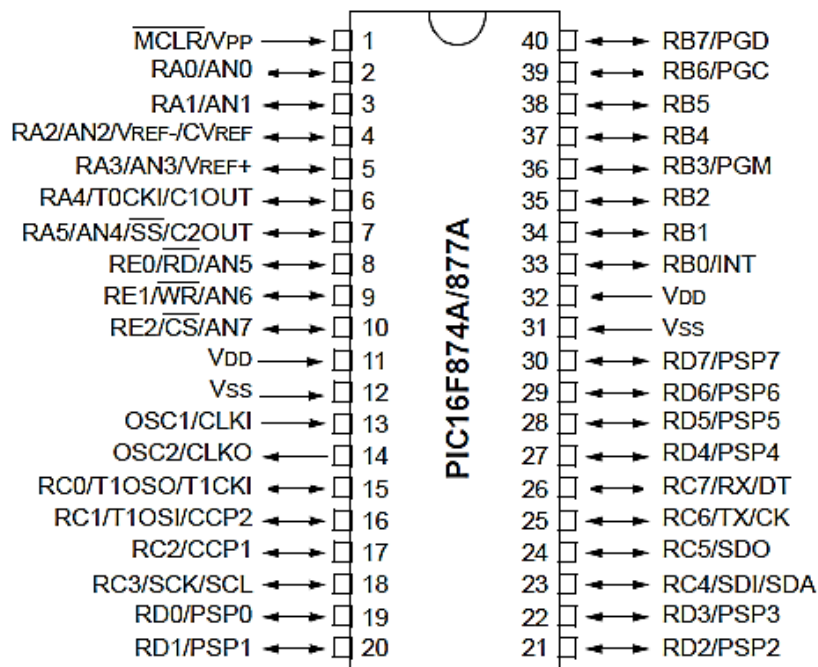


Figure.4.3.Pic16f877a Pin Diagram

ANALOG-TO-DIGITAL CONVERTER (A/D) MODULE

The analog-to-digital (A/D) converter module has eight inputs for 40 pin devices. The A/D allows conversion of an analog input signal to a corresponding 10-bit digital number. A/D converter has a unique feature of being able to operate while the device is in SLEEP mode. To operate in SLEEP, the A/D conversion clock must be derived from the A/D's internal RC oscillator. The A/D module has four registers:

- A/D Result High Register ADRESH
- A/D Result Low Register ADRESL
- A/D Control Register 0 ADCON0
- A/D Control Register 1 ADCON1

The ADCON0 register controls the operation of the A/D module. The ADCON1 register configures the functions of the port pins. The port pins can be configured as analog inputs (RA3 can also be a voltage reference) or a digital I/O.



IRF 540

The IGBT has the fast switching capability of the MOSFET and is capable of handling the high current values typical of a BJT. In addition, IGBTs have a lower on-state voltage drop and are capable of blocking higher voltages. The IGBT, as a first approximation, can be modelled as a PNP transistor driven by a power MOSFET

IGBT SWITCHING BEHAVIOR

One of the important performance features of any switching device is the switching (turn-on and turn-off) characteristic, since significant power losses are incurred during these switching states. When driving inductive loads, the device under goes higher stress. Hence, it makes sense to study the turn-on and turn-of time of the IGBT/MOSFET when driving inductive loads.

The IGBT's internal input capacitance (C_{GE}) and Miller capacitance (C_{GC}) impacts the IGBT turn-on behaviour. But the C_{GC} effect is very small and negligible.

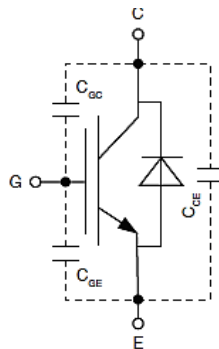


Figure. 4.4 - IGBT Parasitic Capacitances]

Table 4.2 IGBT AND MOSFET Capacitance

CAPACITANCE	IGBTs	POWER MOSFETs
Input	$C_{i88} = C_{GE} + C_{GC}$	$C_{i88} = C_{GE} + C_{GD}$
Reverse Transfer	$C_{r88} = C_{GC}$	$C_{r88} = C_{GD}$
Output	$C_{o88} = C_{GC} + C_{CE}$	$C_{o88} = C_{GD} + C_{DS}$

FLYBACK CONVERTER

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching mode power supply (SMPS) containing at least two semi-conductors switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple. A boost converter is sometimes called a step-up converter since it “steps up” the source voltage. Since power ($P = VI$) must be conserved, the output current is lower than the source current.

The boost converter has the same components as the buck converter, but this converter produces an output voltage greater than the source "Boost" converters start their voltage conversion with a current flowing through the inductor (switch is closed). Then they close the switch leaving the current no other path to go than through a diode (functions as one way valve) The current then wants to slow really fast and the only way it can do this is by increasing it's voltage (akin to pressure) at the end that connects to the diode, and switch. If the voltage is high enough it opens the diode, and one through the diode, the current can't flow back. This is the very basic concept of boost converter. Circuit analysis Analysis of the boost converter begins by making these assumptions:

- The circuit is operating in the steady state.
- The inductor current is continuous(always positive)
- The capacitor is very large, and the output voltage is held constant at voltage V_o . This restriction will be relaxed later to show the effects of finite capacitance.
- The switching period is T , the switch is closed for time DT and open for time $(1-D)T$ The components are ideal Like Buck converter boost also has two mode of operation.

Details are described below Operating principle The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. When being charged it acts as a load and absorbs energy (somewhat like a resistor); when being discharged it acts as an energy source (somewhat like a battery). The voltage it produces during the



discharge phase is related to the rate of change of current, and not to the original charging voltage, thus allowing different input and output voltages.

The basic principle of a Boost converter consists of 2 distinct states :

- In the On-state, the switch S is closed, resulting in an increase in the inductor current;
- In the Off-state, the switch is open and the only path offered to inductor current is through the flyback diode D , the capacitor C and the load R . These results in transferring the energy accumulated during the On-state into the capacitor.
- The input current is the same as the inductor current, So it is not discontinuous as in the buck circuit and the requirements on the input filter are relaxed compared to a buck converter.

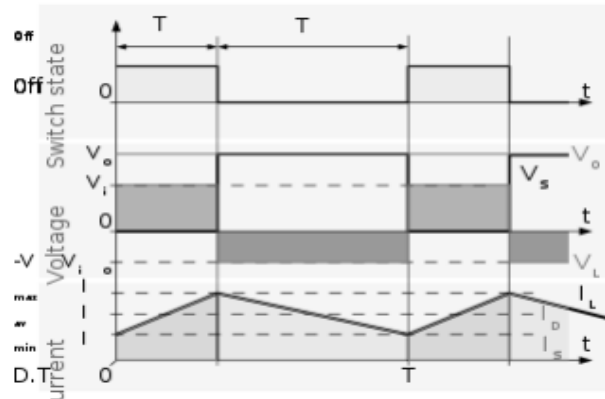


Figure 4.8 (a) typical waveforms of currents

When a boost converter operates in continuous mode, the current through the inductor (I_L) never falls to zero. Figure 4.8 shows the typical waveforms of currents and voltages in a converter operating in this mode.

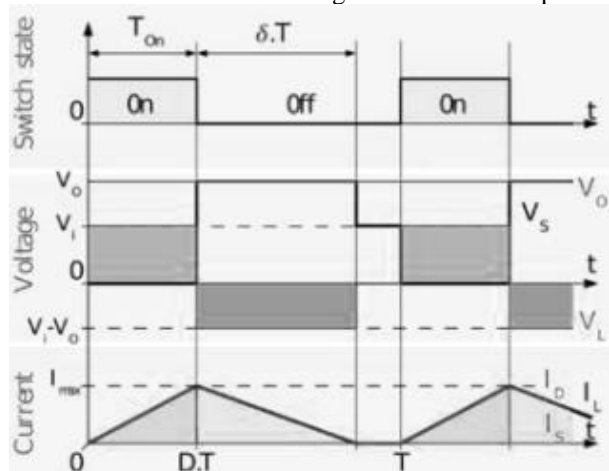


Figure 4.8 (b) voltages in a converter operating in this mode

In some cases, the amount of energy required by the load is small enough to be transferred in a time smaller than the whole commutation period. In this case, the current through the inductor falls to zero during part of the period. The only difference in the principle described above is that the inductor is completely discharged at the end of the commutation cycle. Although slight, the difference has a strong effect on the output voltage equation.

CONVERTER DESIGN

The DC-DC conversion technology is a major subject area in the field of power electronics and drives, and has been under development for past six decades. DC-DC converters are widely used in industrial applications and computer hardware circuits. DC-DC conversion techniques are developed very quickly. This compares to the ac-dc power supply market, which will have a certain growth of only about 7.5% during the same period. In addition to its higher growth rate, the DC-DC converter market is undergoing evaluate changes as a result of two major trends in the electronics industry like low voltage and high power density. From this investigation it can be seen that the production of dc-dc converters in the world market is much higher than that of ac-dc converters.

A simple voltage conversion, the simplest dc-dc converter is a voltage divider (such as rheostat, potential-meter, and so on), but it only transfers output voltage lower than input voltage with poor efficiency. The multiple-quadrant chopper is the second step in dc-dc conversion more time has been spent for to find equipment to convert the dc energy source of one form voltage to another DC actuator with another voltage form, as does a transformer employed in AC-AC conversion. Some initial types of DC-DC converters were used in industrial applications. Research of Dc-Dc converter was blocked during the war, but applications of DC-DC converters were recognized.

After the war, communication technology developed very quickly and required low voltage DC power supplies for the communication. This resulted in the rapid development of DC-DC conversion techniques. Initial stage prototypes can be derived from choppers. The emerging DC-DC converters can be offered as a method to generate multiple output voltage levels from a single source dc supply voltage to feed the different sub-circuits in the device. This method of generating multiple output voltage levels from a single battery source can reduce the area of the device substantially. On the other hand dc supply voltage provided by battery or rectifier contains high voltage ripples (harmonics) and it is not constant enough, thus it is not applicable for most devices. DC-DC regulators are employed to attenuate the ripples regardless of change in the load current or input voltage.

Buck converter is a type of switching-mode power supply which is used for stepping-down dc voltage level. Switch controller circuit and power circuit are two main parts of buck converter circuit. One of the most critical issues for the environment today is pollution generated by hydro-carbon gases, which is one of the main sources of power for transportation. Hybrid electric vehicles (HEV) and full electric vehicles (EV) are rapidly advancing as alternative power trains for green transportation. The electric vehicle application not only involves the traction parts, but it is also generating the new applications for conversion of electric power from load to source. One of the key blocks inside hybrid electric vehicles is the DC-DC converter for auxiliary power supply of electric loads. This converter has to be possible of handling the electric energy transfer from the 12V DC bus and the high voltage DC bus (used for electric traction applications).

The DC-DC converter enables the energy transfer between the high voltage side and low voltage side giving tremendous advantages in terms of low cost, flexible, reliable and efficient, increased due to the possible constraints of easy to make synchronous rectification and implementation. The features include resonant clamping circuit implementation in the boost mode and soft-switching operation, due to phase shift operation, in the buck mode, without need additional devices, and provide high efficiency and easy to control. Power electronic converters and new semiconductor devices are key components to meet the targets of extended mileage range and reduced pollution. The rapidly efficient DC-DC converters must be used to provide appropriate voltage levels and the power management between different energy level sources and storage elements. The proposed developed DC-DC converter is LUO converter it overcomes the parasitic problems present in the classical DC-DC converter. The harmonics Levels present in the LUO converter less compared to the classical buck converter.

CIRCUIT OPERATION OF LUO CONVERTER

The circuit diagram of the Buck - output LUO converter is shown in Figure. 1. In the circuit, S is the power switch and D is the freewheeling diode. The energy storage passive elements are inductors

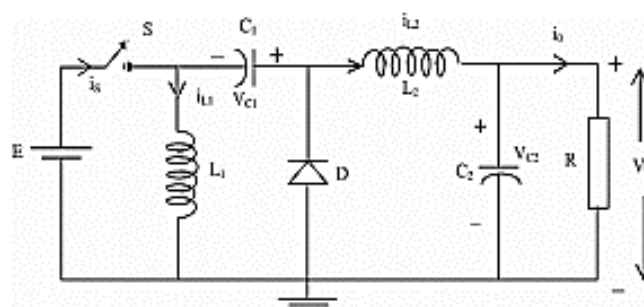


Figure.4.9. Circuit diagram of LUO converter

L_1 , L_2 and capacitors C_1 , C_2 , R is the load resistance. To analyse the operation of the LUO converter, the circuit can be divided into two modes. When the switch is ON, the inductor L_1 is charged by the supply voltage E . At the same time, the inductor L_2 absorbs the energy from source and the capacitor C_1 . The load is supplied by the capacitor C_2 . The equivalent circuit of LUO converter in mode 1 operation is shown in (a). During switch is in OFF state, and hence, the current is drawn from the source becomes zero, as shown in (b). Current i_{L1} flows through the freewheeling diode to charge the capacitor C_1 . Current i_{L2} flows through C_2 - R circuit and the freewheeling diode D to keep itself continuous. If adding additional filter components like inductor and capacitor to reduce the harmonic levels of the output voltage

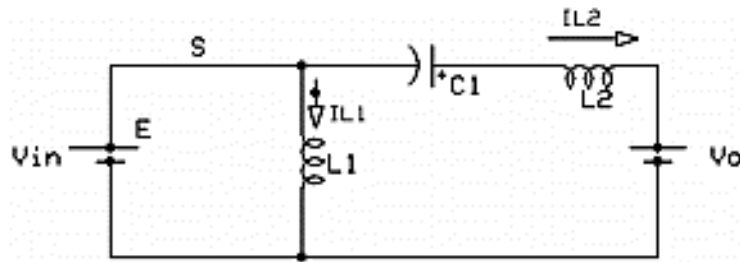


Figure.4.10 (a) equivalent circuit of LUO converter in mode 1 operation

When the switch is ON, the inductor L_1 is charged by the supply voltage E . At the same time, the inductor L_2 absorbs the energy from source and the capacitor C_1 . The load is supplied by the capacitor C_2 . The equivalent circuit of LUO converter in mode 1 operation is shown in (a). Mode 2: switch is in OFF state, and hence, the current is drawn from the source becomes zero, as shown in (b). Current i_{L1} flows through the freewheeling diode to charge the capacitor C_1 . Current i_{L2} flows through C_2 – R circuit and the freewheeling diode D to keep itself continuous.

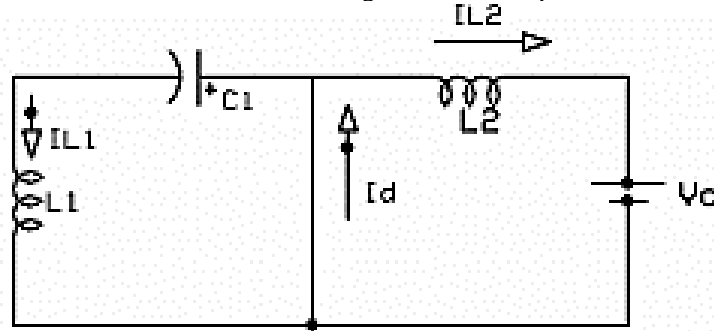


Figure.4.10 (b) equivalent circuit of LUO converter in mode 2 operation

In discontinuous conduction mode, output should be in the form of discontinuous. In this mode diode is not present and inductor discharge through V_0 and L_2 . The output stage of the LUO buck converter is comprised of an inductor and capacitor. The output stages stores and delivers energy to the load, and smooth's out the switch node voltage to produce a constant output voltage. Inductor selection directly influences the amount of current ripple seen on the inductor current, as well as the current capability of the buck converter itself. Inductors vary from manufacturer to manufacturer in both material and value, and typically have a tolerance of 20%. Inductors have an inherent DC resistance (known as the DCR) that impacts the performance of the output stage. Minimizing the DCR improves the overall performance of the converter. For that application it requires a high load current, it is recommended to select an inductor with a low DCR. The DCR is smaller for lower inductor values, but there is a trade-off between inductance and ripple current; the lower the inductance, the higher the ripple current through the inductor.

A minimum inductance must be met in order to meet the ripple current requirements of the specific application circuit. The output capacitance directly affects the output voltage of the converter and the response time of the output feedback loop, also the amount of output voltage overshoot that occurs during changes in load current. A ripple voltage exists on the DC output as the current through the inductor and capacitor increases and decreases. Increasing the value of output capacitance value reduces the amount of voltage ripple present in the circuit. However, there is a trade-off between capacitance and the output response. Increasing the capacitance reduces the output voltage ripple and output voltage overshoot, but increases the response time it takes output voltage feedback loop to respond to changes in load. Therefore, a minimum capacitance must be considered, in order to reduce the ripple voltage and voltage overshoot requirements of the converter, while maintaining a feedback loop that can respond quickly enough to load changes. Capacitors also have a parasitic series resistance, known as the equivalent series resistance (ESR). The steady state capacitor value is 0A shown in Figure (c).

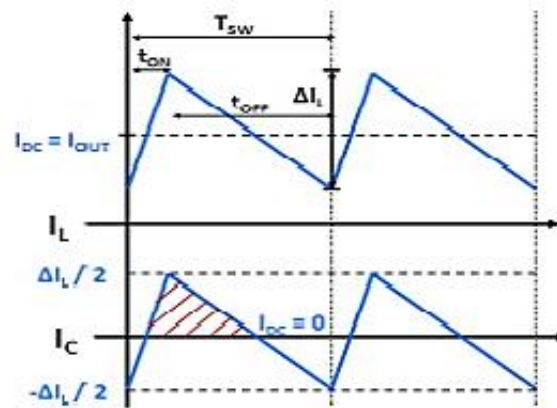


Figure 4.10. (c) The steady state capacitor value

The ESR impacts the output voltage ripple and the overall efficiency of the converter. Because of this, designers are moving to low ESR designs. Surface mount ceramic capacitors are becoming prevalent in systems that require high performance in a small form factor. The choice of multiple capacitors connected in parallel allows designers to achieve the necessary capacitance for the system while greatly reducing the equivalent.

ANALYSIS OF LUO CONVERTER

The inductor current IL2,

$$IL2 = \frac{1-a}{a} IL1 \tag{1}$$

Duty cycle,

$$a = \frac{Ton}{T}$$

Output voltage equation,

$$V0 = \frac{a}{1-a} Vin \tag{2}$$

Average Voltage across the capacitor C1 is,

$$Vc1 = \frac{a}{1-a} Vin \tag{3}$$

Peak to Peak inductor current is,

$$\nabla IL1 = \frac{aTVin}{L1} \tag{4}$$

Equation (4) inductor L1 value,

$$L1 = \frac{aTVin}{\nabla IL1} \tag{5}$$

Peak to peak inductor current L2 is,

$$\nabla IL2 = \frac{aTVin}{L2} \tag{6}$$

Equation (6) inductor L2 value,

$$L2 = \frac{aTVin}{\nabla IL2} \tag{7}$$

The charge on series capacitor (C1) increases during off period by IL2 (=Io) and decreases during on period by IL1. The change in charge on C1 must be zero Peak to peak ripple voltage across the capacitor C1,

$$\nabla VC1 = \frac{1-a}{c1} TI1 \tag{8}$$

Equation (8) C1 value,

$$C1 = \frac{1-a}{\nabla vc1} TI1 \tag{9}$$

SIMULATION RESULTS

In electric vehicle applications, different kinds of electric loads are used. The applicability of the concept on different electric loads used in electric vehicle applications is tested with simulation models that would provide the most realistic predictions. SIMULINK model for Luo converter is shown in (d).

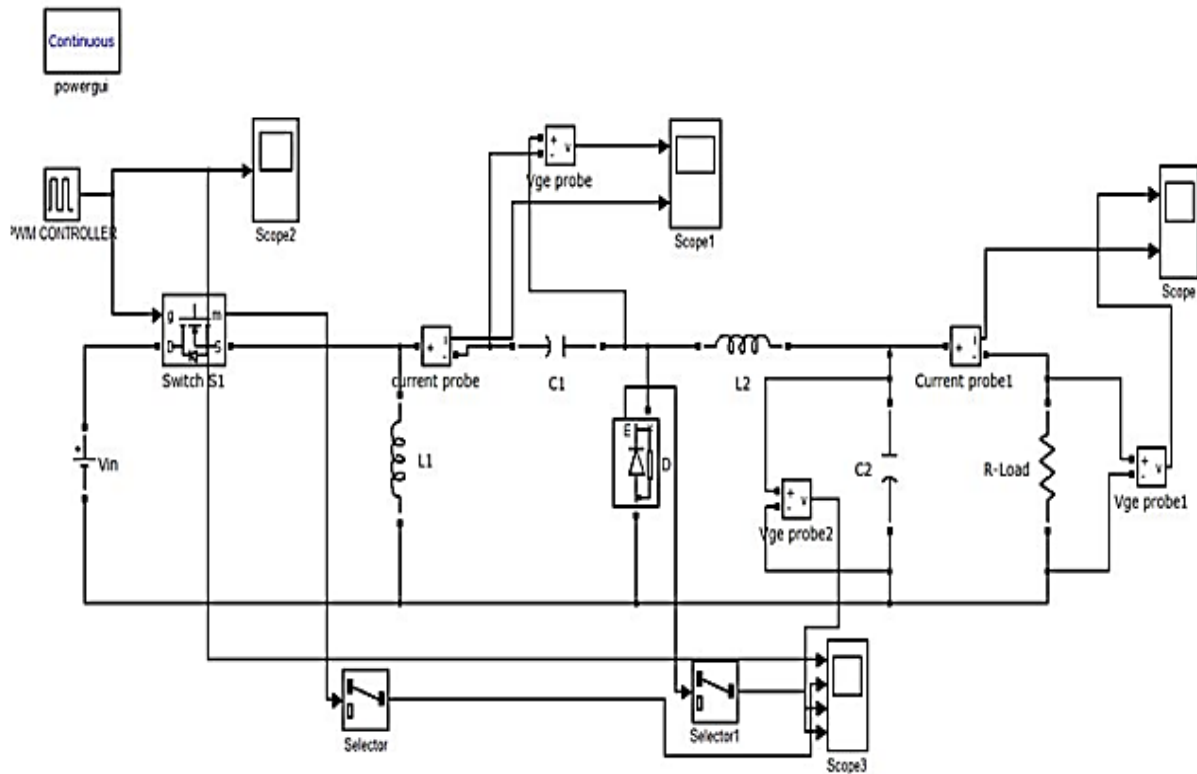


Figure.4.14 a). MATLAB Simulation model

PWM Model

The duty cycle ‘a’ can be generated by comparing the reference dc signal V_r with a sawtooth carrier signal V_{cr} . This is shown in Figure(e), Modulation index is the ratio of carrier signal to reference signal the duty cycle a can be varied from 0 to 1. To obtain the square wave pulses compare these signals by a comparator to generate the difference $(V_c - V_{cr})$. Any variation in V_{cr} varies linearly with the duty cycle ‘a’.

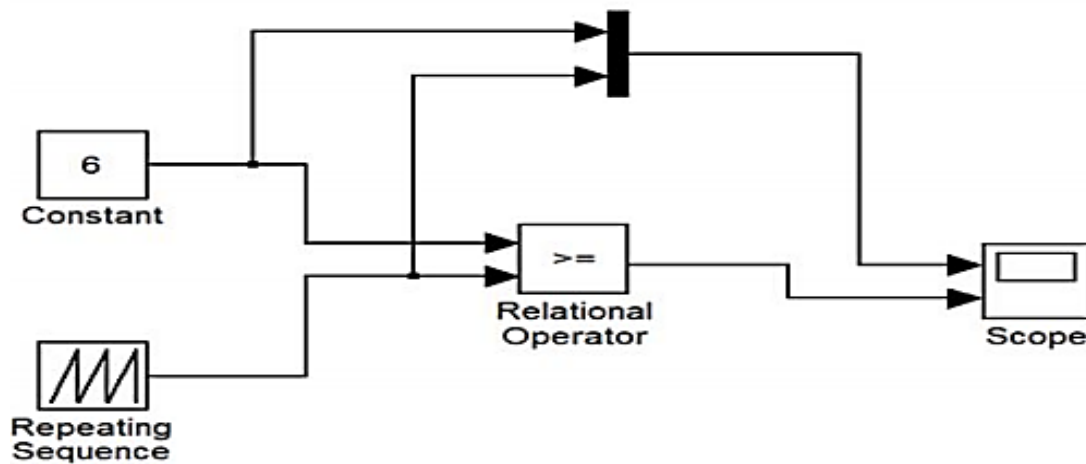


Figure.4.14 b). PWM pulse Generation Block

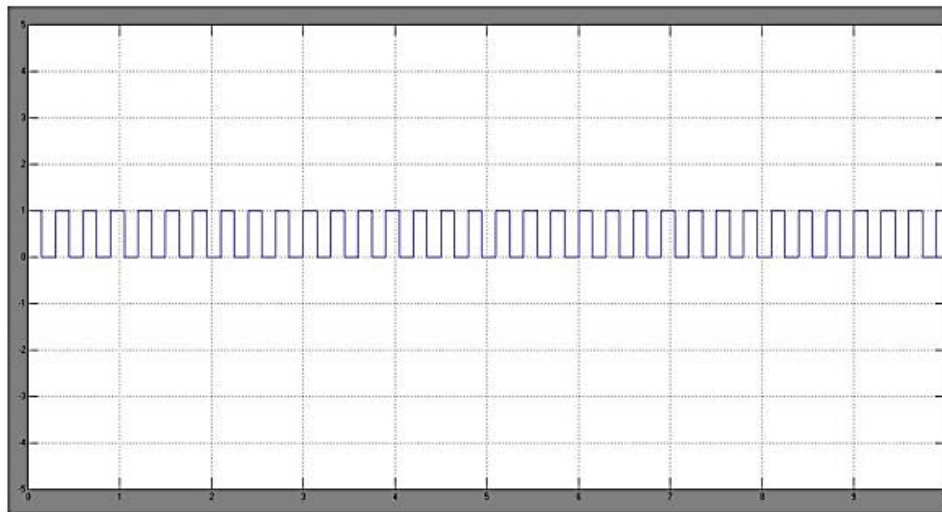


Figure.4.14 c). PWM Output Waveform

Table 4.3. Design Parameters and Simulation Conditions

Input voltage	60V
Output Voltage	12V
Capacitor C1,C2	0.1 μ F
Inductor L1,L2	0.27mH
Switching frequency	50KHz
Load Current	10A

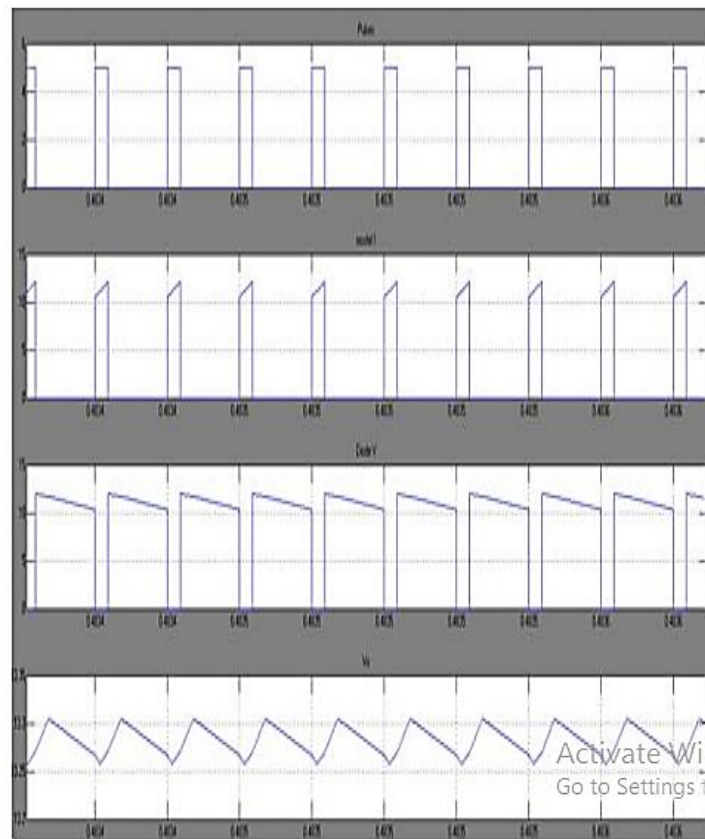


Figure.4.14 d). Different Pulse Generation output



RESULTS

The main motive of this project is to convert the AC supply into DC supply and also to overcome the power quality issues. The Figure 4.14, Figure 4.15, Figure 4.16, and Figure 4.17 are the output. And Figure 4.13 is the project kit. Here bridgeless converter and fly back converter are used. AC supply is used in input stage and it is converted into DC supply. DC supply takes place in output stage. The bridge rectifier is added with the fly back converter and with the help of fly converter and bridge rectifier the AC supply is converted into DC supply. The expected output are Input voltage 12v AC to Output voltage 300v DC, Reduced THD less than 2% and also Improved power factor.

CONCLUSION

This paper proposes a novel single-stage EV fast charging system structure with lower cost and higher efficiency. Both single-stage and two-stage structures are compared under fair efficiency analysis and evaluation including the power loss comparison of the transformers and converters. The whole system efficiency calculation results are also validated by the MATLAB Simulink simulation. The comparison results indicate that the proposed single-stage structure fast charging system could be more effective in efficiency improving while cutting the cost. Besides, based on the proposed single-stage structure, a DCAPF method is also adopted in this paper to compensate the harmonic current which may be directly transmitted to the battery packs. The compensation effect is validated by both the simulation and experimental results. The proposed structure and lower order harmonic current compensation method could be simply used for improving the EV's fast charging system performance

FUTURE WORK

Single-stage power-factor-corrected power supplies usually suffer from high voltage stress, due to lack of control on the intermediate bus capacitor voltage. In this project analysis of such voltage stress was mostly based on steady-state condition without providing sufficient explanation during the transient circuit operation. This project revisits the problem at circuit level and reports that the root cause is due to the inherent negative current feedback property of the output inductor or the transformer operating in continuous conduction mode (CCM).

So the hardware need to be with the multiple converter output or various supply to the Electric vehicle (12V,24V, 64V) with the adjustment of output power either DCM or CCM.

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